Title: XML Schemas for NG Network Description
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Introduction

This watching brief outlines some XML network schemas that have been developed within academia and the telecommunication industry over the recent past. Much of the work is not published in academic journals or conferences.

Literature Reviews

A short survey of schemas has been undertaken and several XML based topology schemas have been investigated which have included:

- The Global Grid Forum (GGF) Network Management Working Group (NMWG) measurement schema [GGF-1] which is seen as a key measurement schema starting point
- Network Description Language (NDL) – used in Grid network management and configuration [NDL-1][NDL-2]
- OPNET network DTD
- OMNET++ XML tools
- The Distributed Management Task Force (DMTF) [DMTF-1] Common Information Model (CIM) schema [DMTF-2]
- TOTEM (MPLS and routing simulation package that has a number of schemas, including topology and traffic schemas)

There is a huge amount of current work in XML based schemas in telecommunications. A report from the ITU-T indicates over 50 groups at major standards bodies producing schemas, many of which are NGN and VOIP related, mostly from a management [ITU-T-1] or service perspective. These groups include 3GPP, ATIS, IETF, ITU-T, ETSI, OASIS and TMF. There has been insufficient time for a thorough analysis of all these initiatives, especially as many initially appear not to be appropriate to this project. For example OASIS appears to be web services based and does not produce network specific schemas.

Summary and Discussion

A short summary is that all these schemas are currently unsuitable as a complete record of an NGN network within the project. They were either limited in scope (e.g. GGF-NMWG, TOTEM), incomplete and under development (NDL) or inappropriate (DMTF-CIM). Two of them are specific to two of the potential simulation tools that may be selected.
The Distributed Management Task Force (DMTF) Common Information Model (CIM) schema covers many aspects of Enterprise network, server and application management. The work of the DMTF is being developed with work in the area of utility computing (data centre management) and extension of Enterprise management with web services and web based management, server control interfaces and so on.

The work on network modelling has been extended through to December 2003 with the inclusion of OSPF schema. The top level scope of the network CIM is shown in Figure 1. The DMTF network model workplan [DMTF-5] indicated a number of extensions to include network topology, MPLS, IPsec and VLANs (within release 2.8) and a clean up of BGP, QOS and extension to VPN, aggregation and protocol end points (due in release 2.9). The version 2.9 schema was published in January 2005 [DMTF-2] but does not contain MPLS and topology extensions.

The XML schemas developed by the DMTF within the CIM are extensive with over 2Mbytes of schema having been developed within an Enterprise perspective rather than from a telecommunications deployment perspective. This schema is not thought to be particularly appropriate for the modelling required in this project. The focus is on network management and Enterprise modelling. The latest schema (v2.9) does not support MPLS, nor network topology, although there is support for QOS, routing protocols, end points, switches and routers.

Figure 1 DMTF CIM Network Model [DMTF-4]
IETF

The work of the DMTF was used as the basis for the IETF Policy working group. This group developed a number of protocol standards in this area such as COPS, however their work is not within XML schema. XML schemas within the IETF cover network management and operations such as NETCONF [IETF-1] and the representation of ASN.1 in XML and an XML network management interface [IETF-2] through to service oriented applications such as description of conferencing (e.g. the MSML – the Media Server Markup Language and the work in such groups as XCON on multimedia conferencing). A standard for IETF usage of XML is provided in RFC 3688 [IETF-3], which indicated the use of the W3C RDF (Resource Description Framework) and W3C schema guidelines.

OPNET

OPNET provide I/O capabilities in XML format. One such DTD [OPNET-2] has been briefly studied. The network definition include network, subnet, node, port, bus, tap, path, path-element, demand-path, profile, point, etc. There has been work in an MSc from Lund University [OPNET-1] which has determined the following workflow for using XML with OPNET based on the BRITE topology generator.

Figure 2 OPNET Workflow with XML topology input [OPNET-1]
OMNET++

OMNET++ uses the NED language which can be mapped one-to-one to XML; the graphical editor is capable of exporting and importing XML. The XML binding for NED means ease of interfacing OMNeT++ with other systems, with XML tools identified in the OMNET++ user manual [OMNET-1], such as nxml library and the utility function xmldoc(). In [OMNET-2] a network topology stored in an SQL database by a network management program can be imported into OMNeT++ in two steps. First, topology data are extracted from the database in XML format, and second, the resulting XML is transformed into NED XML by an XML style sheet transformation (XSLT).

Network Description Language (NDL)

The NDL [NDL-1] [NDL-2] is a configuration language being developed within the grid community in order to enable services over a Next Generation Internet. It is W3C RDF based and has a good core capability including basic service description for topology as shown in Figure 3. NDL also contains a network repository stored in a database and queried with SPARQL, see Figure 4. It may be feasible to extend the NDL in order to describe the different facets of an NGN required within the diverse applications under investigation.

![Figure 3 NDL Classes](image)

<ndl:Device rdf:about="#Rembrandt3">  
  <ndl:name>Rembrandt3</ndl:name>  
  <ndl:locatedAt rdf:resource="#Lighthouse"/>  
  <ndl:hasInterface rdf:resource="#Rembrandt3:eth0"/>  
</ndl:Device>

<ndl:Interface rdf:about="#Rembrandt3:eth0">  
  <ndl:name>Rembrandt3:eth0</ndl:name>  
  <ndl:connectedTo rdf:resource="#Glimmerglass:port3"/>  
</ndl:Interface>

Figure 3 NDL Classes

SPARQL\(^1\) is a SQL-like query language for RDF:

```
SELECT ?host1 ?host2
WHERE { ?if1 ndl:connectedTo ?if2 .  
  ?if2 ndl:connectedTo ?if1 .  
  ?host1 ndl:hasInterface ?if1 .  
  ?host2 ndl:hasInterface ?if2 }
```

Figure 4 SPARQL query language for NDL
TOTEM

TOTEM is a relatively new simulation tool looking at traffic engineering within the Internet [TOTEM-1] specifically looking at MPLS and routing. TOTEM natively uses XML for input and output and provides a BRITE conversion tool to XML. The schemas employed within TOTEM include: domain scenario and traffic. There are examples of a number of NGN like networks such as the Abilene and AT&T networks, in Figure 5 and in Figure 6 the TOTEM repository is shown and interactions with topology discovery and service management.

Figure 5 TOTEM Repository for MPLS LSP computation

Figure 6 TOTEM integration with network control, note XML interfaces to topology discovery and service management
Furthermore TOTEM makes use of measurement data and topology in order to model intra-domain traffic. The process is shown in Figure 7.

**Traffic Matrices generation**  
**Overview**

![Diagram of traffic matrices generation process]

*Figure 7 TOTEM integration with traffic measurements for intra-domain traffic*

**GGF Network Measurement Working Group (NMWG)**

This appears to be the best schema related to network measurement [NMWG-1]. The schema is written using RELAX NG [http://www.relaxng.org/](http://www.relaxng.org/), the relevant tutorial is [http://www.relaxng.org/compact-tutorial-20030326.html](http://www.relaxng.org/compact-tutorial-20030326.html), describing the compact (non-XML) schema and the XML schema is described [http://www.relaxng.org/tutorial-20011203.html](http://www.relaxng.org/tutorial-20011203.html) (XML schema). NMWG uses the compact (non-XML) notation for their measurement framework. There is some information on Grid to do with network measurement: [http://www-didc.lbl.gov/NMWG/old_index.html](http://www-didc.lbl.gov/NMWG/old_index.html). The document GFD-R.023.pdf describes a classification of measurements that could be made in a network. The NMWG schema components are shown in Figure 8.

![Diagram of NMWG schema components]

*Figure 8 TOTEM integration with traffic measurements for intra-domain traffic*
Conclusions

The creation of a set of common schemas is not a simple task, having surveyed some of the work in this area there are a number of schemas that contain partial support, but none that contain a complete representation of an NGN.

A generic and extensible topology schema has been proposed as a starting point. A number of other schemas may be required based on the requirements from other outputs. These schemas may be developed as extensions of the topology schema and may include extensions for QOS, routing, MPLS, network services, traffic etc. as indicated in examples such as TOTEM and the DMTF.